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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,695	03/30/2001	Si Yi Li	015290-500	4162

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EXAMINER	
OLSEN, ALLAN W	

ART UNIT	PAPER NUMBER
1763	

DATE MAILED: 06/06/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/820,695	LI ET AL.	
	Examiner	Art Unit	
	Allan Olsen	1763	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 February 2005* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3,5-7 and 9-25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,5-7 and 9-25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *20 March 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 5-7, 9, 11, 14-16, 19-21 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 6,693,042 issued to Sedigh et al. (hereinafter, Sedigh).

Sedigh teaches a method that comprises the plasma etching a low-k dielectric material such as fluorine-doped silicon oxide. Sedigh teaches using an etchant comprising a hydrofluorocarbon, for example, $C_xH_yF_z$ wherein $x \geq 2$, $y \geq 2$ and $z \geq 2$. Sedigh teaches that nitrogen and other fluorinated compounds such as CF_4, C_4F_8, C_4F_6 and C_5F_8 may be added to the etchant (column 10, line 38). In one embodiment, Sedigh teaches using CF_4 at a flow rate of 10-60 (column 11, lines 10-11) and nitrogen at a flow rate of 5-25 sccm (column 11, lines 14-16). Sedigh teaches patterning the dielectric by etching through an overlying hard masking material, such as undoped silicon oxide (column 9, lines 37-40). Sedigh teaches the dielectric layer overlies a

conductive layer, for example aluminum (column 7, lines 11-18). Sedigh teaches etching patterns with features smaller than 0.2 microns (column 13, lines 18-20). Sedigh teaches the method is part a damascene process in which the etched feature is subsequently filled with metal (column 13, lines 10-30). Sedigh teaches using an apparatus with high and low frequency RF power (column 9, lines 5-8). With respect to the newly recited "single-fluorocarbon etching gas", the examiner does not considered claim 1 to be limited to using an etchant that consists of only one fluorocarbon. The examiner notes that claim 1 uses open (i.e. "comprising") claim language, as such, Sedigh's provision of C_xF_y meets the limitation of "supplying an oxygen-free single fluorocarbon etching gas.

Sedigh does not explicitly teach a method in wherein one of C_4F_8, C_4F_6 and C_5F_8 is used in conjunction with a greater amount of nitrogen.

It would have been obvious to one skilled in the art at the time the inventions was made to use C_4F_8, C_4F_6 or C_5F_8 in conjunction with a greater amount of nitrogen because Sedigh provides an example in which CF_4 is used in conjunction with a greater amount of nitrogen and Sedigh teaches that CF_4, C_4F_8, C_4F_6 or C_5F_8 may be provides as an additional fluorocarbon. Therefore it would be obvious to use a flow rate of C_4F_8, C_4F_6 or C_5F_8 that would provide a comparable amount of C and F to the plasma as was provides by Sedigh's use of CF_4.

Claims 22 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,843,847 issued to Pu et al. (hereinafter, Pu).

Pu teaches a method of plasma etching doped glasses such as PSG and BPSG (column 3, lines 54-58). Pu teaches an oxide: resist selectivity of at least 10:1 (column 8, line 40). Pu teaches an etchant composition comprising a fluorocarbon selected from a second group that includes C_4F_8, and a fluorocarbon selected from a first group that includes CF_2H_2, and N_2. Pu teaches a N_2: combined fluorocarbon (e.g., $C_4F_8 + CF_2H_2$) flow ratio of up to 5:1 and a first fluorocarbon to a second fluorocarbon (e.g., CF_2H_2: C_4F_8) ratio of 1:1 (column 5, line 64 - column 6, line 2; column 6, lines 20-24; column 7, line 6. claims 29 and 37).

Pu does not explicitly teach the combination of C_4F_8 and CF_2H_2.

It would have been obvious to one skilled in the art to use the $C_4F_8 + CF_2H_2$ combination because C_4F_8 is identified as the preferred fluorocarbon from the second group and CF_2H_2 is but one five fluorocarbons which belong to the first group.

Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Pu as applied to claim 22 above, and further in view of Koshiishi et al. in "Effect of Increasing the Upper Frequency on Dual Frequency Capacitive-Coupled-Plasma", Proceedings of Symposium on Dry Process, The Institute of Electrical Engineers of Japan, Nov 11-13, 1998, pp229-234 (hereinafter, Koshiishi).

Pu does not teach a dual frequency plasma system.

Koshiishi teaches etching in a dual frequency plasma system wherein the pedestal electrode and the showerhead electrode are provided with different frequencies of RF energy.

It would have been obvious to one skilled in the art to use the RF frequency scheme of Koshiishi because Koshiishi teaches that this enables greater control over

the etching process. For example, Koshiishi teaches this enables the use of lower pressure, which in turn improves the extent of microloading

Claims 1-3, 5-7 and 9-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. patent 6,455,411 issued to Jiang et al. (hereinafter, Jiang) in view of Koshiishi.

Jiang teaches plasma etching a low-k dielectric layer. Jiang teaches using an etchant comprising a fluorocarbon and a greater amount of nitrogen. Jiang teaches etching low-k dielectric layers (106 and 108) through an overlying patterned layer of SiN (capping layer 110). The patterned SiN functions as a mask for the subsequent etching of the underlying layer of low-k dielectric. Jiang teaches etching a layer of low-k dielectric that is disposed upon an underlying layer of SiC (104). C4F8, C5F8, C4F6, and CH2F2 are among the fluorocarbons etchants that Jiang teaches. Jiang teaches adding Ar to the etchant. Jiang teaches an etchant mixture consisting of C4F8, N2 and Ar. Jiang teaches etching a layer of low-k dielectric material that overlies a barrier layer comprising TaN. Jiang teaches using a fluorocarbon flow rates that is less than 30% of the nitrogen flow rate. Jiang teaches the etched feature is filled with metal. See: column 2, lines 56-58; column 2, line 65 - column 3, line 26; column 3, lines 33-63; column 4, lines 1-2, 26-46.

Jiang does not teach etching a feature with at least a 5:1 aspect ratio. Jiang does not teach a dual frequency plasma system. Jiang does not teach using an etchant that consist essentially of C5F8, N2 and Ar. Jiang does not teach the temperature of the substrate support.

It would have been obvious to one skilled in the art to use an etchant consisting of C5F8, N2 and Ar because Jiang teaches an etchant consisting of C4F8, N2 and Ar and Jiang also teaches that C4F8 and C5F8 are functional equivalents as the fluorocarbon component of the etchant mixture. The substitution of equivalents is obvious and requires no express motivation as long as the prior art recognizes the equivalency[1]. It would have been obvious to one skilled in the art that Jiang was applicable to etching of features with a 5:1 aspect ratio because Jiang teaches etching a contact hole to a depth of 10,500 angstroms and the industry standard for the size of contact holes at the time of Jiang's disclosure was .2 microns or less and in combination with an etching depth of 10,500 angstroms, this corresponds to a 5:1 aspect ratio.

Koshiishi teaches etching in a dual frequency plasma system wherein the pressure is up to 11 Pa (82.5 mTorr) and the pedestal and showerhead electrodes are provided with different frequencies of RF energy.

It would have been obvious to one skilled in the art to use the RF frequency scheme of Koshiishi because Koshiishi teaches that this enables greater control over the etching process. For example, Koshiishi teaches this enables the use of lower pressure, which in turn improves the extent of microloading.

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[1] *In re Fount* 213 USPQ 532 (CCPA 1982); *In re Siebentritt* 152 USPQ 618 (CCPA 1967); *Graver Tank & Mfg. Co. Inc. v. Linde Air Products Co.* 85 USPQ 328 (USSC 1950).

It would have been obvious to one skilled in the art to appropriately adjust the process parameters such as the temperature of the substrate support because optimization of such parameters is considered to be obvious.[2]

Response to Arguments

Applicant's arguments, filed February 22, 2005, have been fully considered but are not persuasive. Applicant's arguments are bases on the premise that the newly recited "single fluorocarbon" and "oxygen-free" limitations have the effect, respectively, of excluding the presence of more than one fluorocarbon and excluding the presence of oxygen. However, the examiner notes that the claims are use "comprising" or open claim language and therefore the claims as recited do not in fact provide for the exclusions that applicant's arguments are based upon. It is noted that the a reference that teaches providing a reaction chamber with C4F8, is considered to teach providing a single fluorocarbon, oxygen free gas, regardless of what other gases may or may not be added the reaction chamber.

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[2] "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art... such ranges are termed "critical ranges and the applicant has the burden of proving such criticality... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

In re Aller 105 USPQ 233, 255 (CCPA 1955). See also *In re Waite* 77 USPQ 586 (CCPA 1948);

In re Scherl 70 USPQ 204 (CCPA 1946); *In re Irmscher* 66 USPQ 314 (CCPA 1945); *In re Norman* 66 USPQ 308 (CCPA 1945); *In re Swenson* 56 USPQ 372 (CCPA 1942); *In re Sola* 25 USPQ 433 (CCPA 1935); *In re Dreyfus* 24 USPQ 52 (CCPA 1934).

With respect to applicant's challenge to the Official Notice taken by the examiner regarding the industry standard for the size of contact holes at the time of Jiang, the examiner herein cites the following:

1) "After Moore's Law, Why Multiple Processors Matter", MacMusings by Dan Knight, (November 02, 1999) (http://www.lowendmac.com/musings/moore.shtml), wherein it states, "Today's newest designs use 0.18 micron elements".

2) "Intel, IBM put chip development in fast lane", by Michael Kanellos (Dec. 10, 2000), (http://news.com.com/Intel%2C+IBM+put+chip+development+in+fast+lane/2100-1001_3-249656.html),
wherein it states, "Early in the last decade, Moore himself said the industry probably would hit a wall when transistors shrunk to around 0.25 microns, Marcyk said. Chips with transistors that sizes that came out in 1997 and now are old fashioned. Most companies manufacture chips with 0.18 micron elements and will start to make 0.13 micron chips in late 2001."

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the

shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allan Olsen whose telephone number is 571-272-1441. The examiner can normally be reached on M-F 1-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on 571-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Allan Olsen
Primary Examiner
Art Unit 1763